II.

SUMMARY

This report contains the staff evaluation of environmental tobacco smoke's (ETS) physical and chemical characteristics; sources and emissions; a review of measured and modeled air concentration studies on the constituents of ETS; the results of ARB's recent ETS air monitoring study; scenario-based estimates of selected population subgroups' exposures to ETS under different smoking conditions; and the atmospheric persistence of selected ETS constituents. This report, along with the Office of Environmental Health Hazard Assessment's (OEHHA) health evaluation report (Part B), will serve as the basis for the identification of ETS as a toxic air contaminant (TAC) under the authority of California's TAC Program (Assembly Bill 1807: Health and Safety Code Sections 39660-39662).

A brief summary of the information presented in the report is provided below.

Chapter III - Chemical and Physical Properties

- ETS is a complex mixture of several thousand individual gaseous and particulate compounds, many with known adverse health effects.

- ETS is produced primarily by the release of smoke from the burning tip of cigarettes and cigars between puffs (i.e., sidestream smoke) and the smoke exhaled by the smoker (i.e., mainstream smoke). Other components of ETS are the mainstream smoke emitted from the mouthpiece of cigarettes and the vapor compounds that diffuse through the wrapper.

- ETS contains several tobacco-specific nitrosamines (TSNAs). TSNA's are one of the major cancer causing agents found in tobacco smoke. N-nitrosonornicotine (NNN) and 4-(methylnitrosamino-)-1-(3,pyridyl)-1-butone (NNK) are believed to be the most potent carcinogens of this class.

- Researchers have also identified at least ten polycyclic aromatic hydrocarbons (PAHs) in ETS as cancer causing toxic air contaminants. One of the most potent cancer causing PAH in ETS is benzo[a]pyrene.

Chapter IV – Production, Uses, Sources, Emissions and Smoking Trends

- Most of all tobacco is grown on the East Coast or Midwest in the United States.

- According to the most recent surveys on smoking prevalence, California sources of ETS emissions appear to originate from approximately 16% of the adult and adolescent California population.

- The California Tobacco Survey, developed by the California Department of Health Services, indicates that during the past decade, smoking prevalence among adults and adolescents has gradually decreased.

- Current smoking prevalence data was taken from the Department of Health Service's California Tobacco Survey (2002 data for adult smokers) and the California Student Tobacco Survey (2001 data for adolescent smokers) to estimate that about 16% of the California adult/adolescent population smokes.

- Since 1980, total and per capita cigarette consumption has continued to decline every year. With continuous statewide anti-smoking programs being implemented, this trend may continue.

- 2002 emission estimates of ETS from cigarettes and cigars in California and the U.S. are:

	California	U.S.
Nicotine:	40 tons/yr	647 tons/yr
Respirable Suspendable Particulate:	365 tons/yr	5860 tons/yr
Carbon Monoxide:	1907 tons/yr	30,200 tons/yr

Chapter V – Exposure to Environmental Tobacco Smoke

California Activity Patterns and ETS Prevalence

- An individual's exposure is equally dependent on the air concentration of a pollutant in a given environment, and the time they spend in that environment.

- California activity pattern data suggest that a majority of a person's daily activity is spent indoors, especially at home. California adults spend about 62% of their time in their home, and children under 12 years of age spend about 76% of their time in the home, on average. Children also spend more time outdoors (10%) than adults and adolescents (6%).

- According to data from the early 1990s, on a given day, 38% of children (0-11 years), 56% of adults (over age 18), and 64% of adolescents (12-17 years) may be exposed to ETS during their daily activity.

- Recent data show that smoking prevalence continues to decline.

Monitoring ETS Constituents

- Exposure to ETS is difficult to characterize because it is a complex mixture of substances and the difficulty of determining an appropriate marker that is representative of ETS as a whole.

- Several components of ETS have been studied as markers for ETS. Nicotine has been most widely studied as a potential marker because its only source is

tobacco smoke. Other ETS markers that have been studied include: solanesol, 3-ethenylpyridine (3-EP), carbon monoxide, iso- and anteisoalkanes (C_{29}-C_{34}), PAHs, fluorescing particulate matter, respirable suspended particles, and ultraviolet particulate matter.

- The ARB monitored nicotine concentrations at several outdoor smoking areas in California. The study gathered two 8-hour samples and six 1-hour samples per site tested. Depending on the site location and number of smokers present, the results show that the range of concentrations vary from 0.013-3.1 microgram of nicotine per cubic meter of air (μg/m^3) for the 8-hour samples and 0.016-4.6 μg/m^3 for the 1-hour measurements. Overall, the results indicate that concentrations of nicotine correspond to the number of smokers in the smoking areas, although factors such as the size of the smoking area and wind speed affected the results.

Indoor ETS Concentrations

- Current indoor concentrations of nicotine in California are estimated to range from 0.5 (low exposure) to 6.0 (high exposure) μg/m^3 in the home environment, 2-8 μg/m^3 in offices or public buildings where smoking is permitted, and less than 1 μg/m^3 in public buildings where smoking is prohibited.

- Certain workplaces, such as the approximately 20% of free-standing bars that are not yet compliant with California's workplace smoking ban, would likely have elevated levels of ETS based on measurements made across many studies in such locations. Concentrations in these locations may range from 9.8 μg/m^3 in betting establishments to 76.0 μg/m^3 in bingo parlours.

Exposure Estimates

- A scenario-based approach was used to characterize the range of the public's exposure to ETS. The scenario-based exposure method uses the results from ARB's ETS monitoring study, available indoor ETS concentration data, and scenario-based activity patterns to estimate exposures under different conditions.

- The results show a wide range of possible subgroup exposures. For individuals living in non-smoking homes and having only brief encounters with ETS, exposures are low, about 1 μg-hr/m^3. For those living in homes with smokers, indoor and in-vehicle exposures are predominant and high, as would be expected, ranging up to 81 μg-hr/m^3, and potentially even higher in the actual population. Such exposures are especially of concern for young children, both because they are likely to recur daily and because of the potential additional physiological sensitivity of developing children.

- The primary and often the only exposure for individuals that do not spend time near smokers, exposure occurs outdoors in locations over which the individual typically has little control. For non-smokers whose work or other activities bring

them into contact with outdoor smokers regularly, 100% of their exposure can be attributable to proximity to outdoor smoking.

Biological Markers of ETS Exposure

- Biological markers of ETS exposure are metabolites of tobacco smoke ingredients found in physiological fluids or attached to DNA or proteins.

- Biological markers are useful in quantifying the amount of exposure to ETS. The ability to quantify exposure objectively is an important step in linking exposure to relative risk of adverse outcomes.

- Cotinine, a metabolite of nicotine, is the biological marker of choice in most epidemiological studies. Physiological fluid levels correlate very well with ETS exposure documented both by questionnaire and by personal exposure monitoring.

- Cotinine levels differ between smokers and ETS-exposed non-smokers by 2 to 3 orders of magnitude. From an epidemiological perspective, this difference is useful in that persons that misrepresent their smoking status may be excluded from study cohorts. Cotinine assays are sensitive enough that individuals without ETS exposure can be distinguished from those persons with low exposure.

- The nicotine concentration in hair is emerging as another viable biological marker of ETS exposure. In some instances, hair nicotine has been shown to better correlate with exposure than cotinine.

- The best predictor of cotinine levels, and hence exposure, in children is the number of cigarettes smoked in the home. Younger children appear to have higher exposure levels than adults. Asthmatic children may have lower clearance rates for ETS constituents than non-asthmatic children. Tobacco-specific lung carcinogens have been measured in children and correlate with ETS exposure.

Chapter VI – Atmospheric Persistence

- The combustion of cigarettes includes at least three important types of reactions, including pyrolisis, pyrosynthesis, and distillation. The result of these reactions is the production of thousands of gaseous and particle constituents. This mixture undergoes additional chemical reactions as the mix is diluted with ambient air, yielding individual compounds with their own atmospheric lifetimes.

- Gaseous chemicals that are present in ETS can react in the atmosphere with other pollutants and sunlight to form new chemical species. The ETS particles and particle-associated chemicals (those with low vapor pressure that deposit or chemically bind onto the particles) are subject to wet and dry deposition and atmospheric transformation of species adsorbed to the particles.

- Nicotine, the principal alkaloid in tobacco, is most commonly found in the gas phase in the environment. In the ambient air, nicotine may react with hydroxyl radicals to have a half-life of approximately one day.